# Update on NAJPTC Project

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# NAJPTC Project Objectives

- Demonstrate PTC Safety Functionality
  - Prevent Train to Train Collisions
  - Enforce Speed Restrictions
  - Protect Roadway Workers Operating Under Specific Authorities
- Demonstrate Revenue-Ready System for Operation of Passenger Trains > 79 mph Intermixed with Freight Trains
  - Ultimately Reduce St. Louis-Chicago Transit Time from 5 ½ to 3 ½ hours
- Develop Interoperability Standards
  - Equipped trains enter foreign RR at track speed

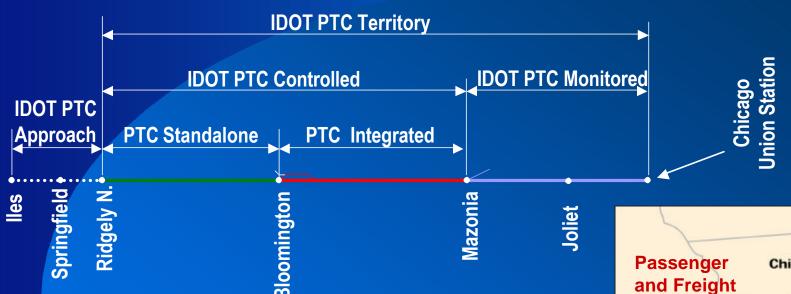


# System Features

- Warnings / Enforcement of Authorities and Speeds
  - Warnings provided in advance (except emergencies)
  - Enforcement is last resort
- Locomotive Activation of Crossing Warning Systems
  - Eliminates need to extend crossing track circuits for high speed operation
- Modular Design
- Pacing & Fine Resolution Train Tracking
  - Potential to improve velocity / capacity / service reliability
- Flexible Block
  - Permits closing up of trains reduces freight train delay during overtakes
  - Potential to alleviate need for wayside signals
  - Increases capacity without adding track
- Cost Effective



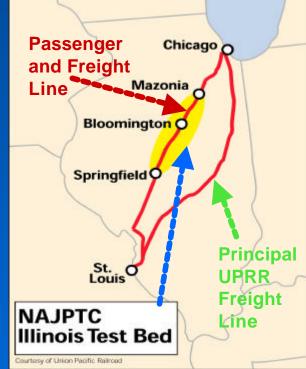
# Overview of IDOT PTC Territory



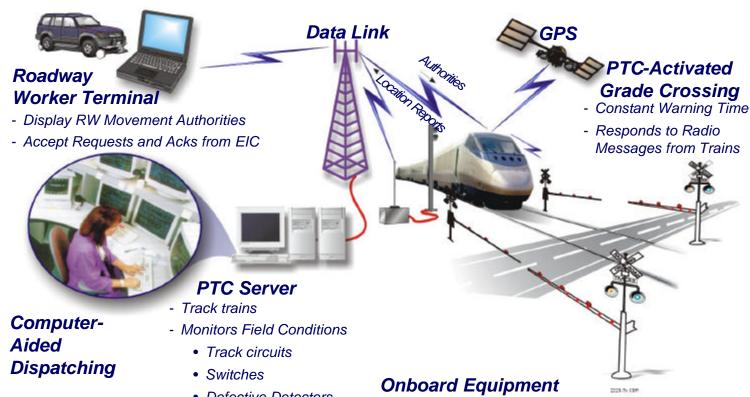
### **Handle Mixed Traffic ...**

- Passenger
- Freight
- Non-Communicating Trains





## PTC CONOPS



- Defective Detectors
- Computes Authority Limits
- Transmits Movement Authority & Speed Restrictions to Trains

- Displays Authorities and Speed Restrictions
- Warns Crew when Approaching Limits
- Warns of Roadway Workers performing Authorized Work on Track
- Enforces Authorities and Restrictions
- Reports Location to Server



PTC uses Mobile Data Radios and Onboard Location Determination

# **Project Challenges**

- Large, Complex, Distributed, Real Time System
  - ~200,000 Lines of Code, mostly Safety Critical
  - Very High Safety Threshold
  - Can't Depend on Human Override for Safety
  - Wireless Comm in the Loop
- Must Determine Vehicle Location with Much Higher Integrity than with D-GPS alone
- Must Accurately Predict Stopping Distance and Crossing Arrival Time based on Data Sources with Varying Accuracy
- New FRA Safety Regulations (NPRM)
- Diverse Customer Organization



Lots of Enthusiasm and Support

## Schedule and Builds

2001

2002

Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4

2003

2004

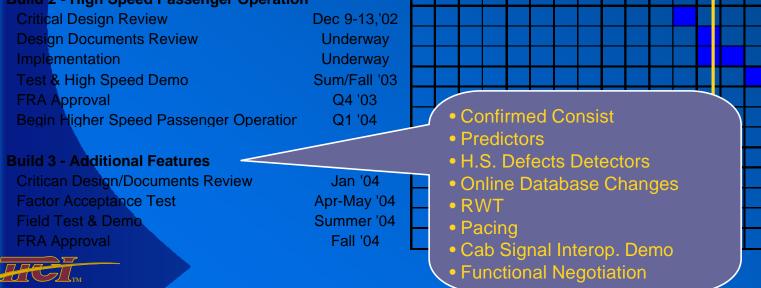
2000

**SDI Contract Award** Jul '00 System Design Review Dec '00 Preliminary Design Review Jul '01

#### **Build 1 - LDS, Reporting, Tracking**

Critical Design/Documents Review Q4,'01 - Q1,'02 **Factory Acceptance Test** Jul 18-20, '02 Field Test & High Speed Demo Oct 26-31, '02 All Hardware Designed; Most Delivered Q4,'02

#### **Build 2 - High Speed Passenger Operation**



# PTC Build 1 Field Tests & 110 mph Demo











# Summary of PTC Project Status

- Project Schedule and Funding Issues Resolved
- ◆ Build 1 Complete
- ◆ Upgrades to UPRR CAD Complete January 2003 ✓
- ♦ New ATCS Comm Network In Territory Complete ✓
- ◆ 5 Amtrak & 1 UP Locomotives Fitted w/PTC Hardware ✓
- All Wayside Equipment Delivered
- Signal System Upgrade in Territory Cutover in 2003
- Track Upgrades (Class 6) in Territory Nearly Complete
- ◆ RFI for 3<sup>rd</sup> Party Safety Assessment Issued ✓
- Build 2 High Speed Train Control Development Underway;
   To be Complete by End of 2003



Build 3 – Additional Features in 2004

# IDOT PTC Safety Program Update

Presented at RSAC 5 March 2003 Philadelphia, PA

Craig Shier Lockheed Martin

## PTC Safety Program Status

### Major Milestones Recently Completed

- Build 1 Field test validates LDS performance in November
- NPRM and RSPP updated requirements incorporated in contract
- Build 2 Critical Design Review held December 9-13
- RVCCM traces each System Requirements to acceptance criteria and test conditions
- ASCAP Peer Review with Labor 5,6 February
- First Installment of Safety Documents delivered to FRA
- Detailed Design Documentation Delivered with Safety Assurance Concepts and Fault Tree Analysis

#### Near Term Goals

- Final Safety Analysis of Detailed Design (SSHA, FMEA)
- Comment Resolution for Design Documents

## Field Test Performance Summary

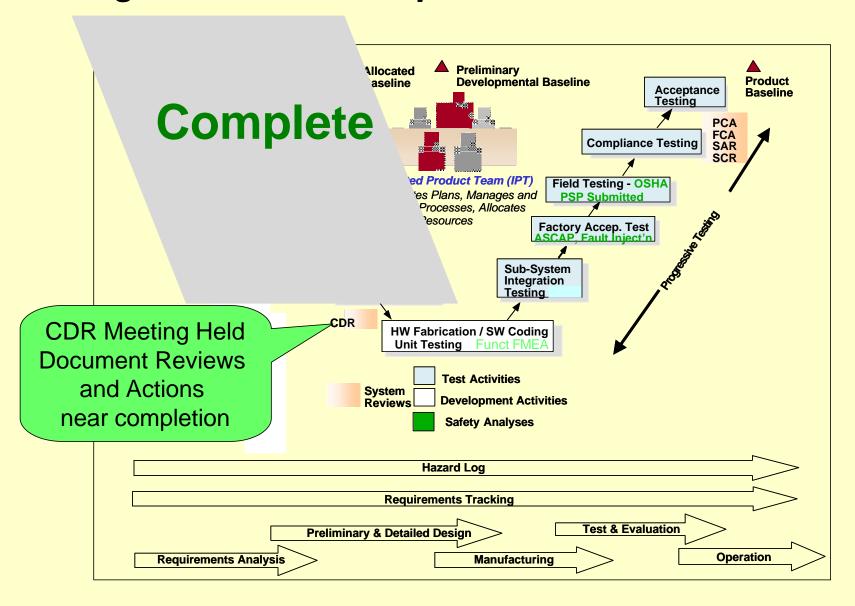
- NO TEST FAILURES!!
- Successfully completed all planned testing (32 test over 10 runs)
- Customer free-play completed with NO test failures
- Several Observations / Non-Test-Failure Problems Written
  - OBD displays / windows / text
  - Failure messages and reporting
  - LDS false alarms / limits for failure reporting
- Initial LDS summary
  - Detected 100% of turnouts (112 of 112)
  - Speed and Reporting within spec

# IDOT PTC Field Test Performance Summary (Oct 26-29, 2002)

- IDOT PTC Formal Field Testing was successfully performed on the 26th, 27th, and 28th (AM) of October, 2002
  - Total of 32 tests performed over 10 test territory runs (5 North, 5 South)
    - 21 Unique tests; 1 test (location/speed run) is repeated 12 times
      - No Test Failures were reported
      - 23 tests ran with no reported problems
      - 9 tests ran with non-test-failure problems reported
        - Agreed acceptable to address for Build 2 by SDI and Customer Team at each days de-briefing
  - Customer "Free-Play" testing was also successfully performed on the 28th (PM) of October, 2002
    - No Test Failures were reported
    - 2 reported problems to be addressed for Build 2

# 4

### Program Schedule Dependencies



## Status of IDOT PTC Safety Program Deliverables

- FFT Accepted by PO, sent to FRA.
- PHA Accepted by PO, sent to FRA.
- Safety Requirements Doc Accepted by PO, sent to FRA.
- Part 236 A-G Applicability Matrix Accepted by PO, sent to FRA.
- Safety Assurance Concepts reviewed, SDI revisions in internal review
- PSP Outline/Container almost done.
- Fault Trees Complete
- SSHA(s) Complete by 3/15
- ASCAP Base Case Initial assessment complete, peer reviews in process and "long" runs with projected traffic.

### UVA Status - "Peer Review" Plans

- Verify model assumptions and output correspond reasonably well to operational experience (qualitative and quantitative)
- Key elements to review:
  - Broken rail model failure rate and coverage
  - Train movement randomization over operational horizon
  - Failure rate as function of time and usage over the operational horizon
  - Review the base case data Validation & Verification
  - Blackboards (i.e. Operating Rules) Validation & Verification
  - Base Case Proof-of-Safety Findings
    - Mishap Logs
    - Comparison of Modeled Mishaps with Hazard Log
    - Mishap vs. Accident classification

# Peer Review Phase 1 Highlights

- Discussion of Agent-Object Interactions (Blackboards)
  - Expand roadway worker behavior considerations
    - Form A, Form B, Track & Time
    - Worker protection, flagging, etc.
    - Working hours
    - Effects of work crew clean must be included
    - Dispatcher shift changes
  - Expand Train behavior considerations
    - Allow for over speed, emergency and full service braking
    - Allow both "acts of omission" and "acts of commission"
  - Signal behavior must be refined
    - Include Flashing Red & lunar white signals
    - Reflect light out protection as identified in US&S provided Boolean expressions
    - Modify train movement at signals to conform to UPRR /GCOR rules
    - Separate blackboards for intermediate and control point signals

## Peer Review Phase 1 Highlights Continued

- Develop blackboards for hand thrown switches
- Discussed String Charts and typical delay scenarios
- Documentation Review
  - Terminology Updates e.g. MOW to Roadway Worker
  - Readability, Format recommendations

#### Action Items

- Obtain statistics on actual Form A, B, Track and Time Issuance
- Confirm/refine priority passenger/freight priority.
- Improve tabulation of different types of EPAD occurrences
- Update Model and Documentation

# Standards Update

PTC RSAC March 5, 2003

# Standards

- AAR has standards body of work published in the Manual of Standards and Recommended Practices (MSRP).
- Communications based train control and other electronic standards will be published in the MSRP.
- AAR standards oversight structure:
  - Safety and Operations Management Committee and the subordinate Communications, Signal and Train Control Working Committee to:
    - NAJPTC Management Committee train control
    - Railway Electronics Task Force Configuration Management for Section K MSRP (electronics)
    - Wireless Communications Task Force wireless communications

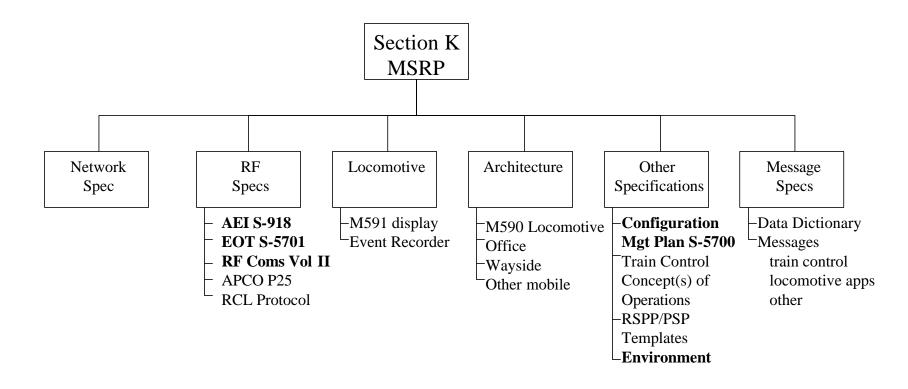
# Standards

- The NAJPTC Program Standards Project primarily supports the message specification development
  - May include Train Control Concept of Operations and templates for RSPP and PSP
- RETF is sponsoring other standards and specifications on AAR nickel, including
  - Network Specification
  - Locomotive Electronics Architecture etc.
  - Other committees and task forces review and approve RETF products e.g. WCTF, NAJPTC Management Committee

# Current RETF Activities

- Developing and incorporating specifications into Section K MSRP
  - For instance Railway Communications Volume II Section
    - Communications Protocol for 900 MHz "ATCS", including MCP, BCP, CC, and FEP
- Will allow for on line purchase and download of Section K and other MSRP documents at AAR website this year
- Have active change management process supported by TTCI staff and contractors

# Electronic Standards Tree



**Bold indicates current adopted specifications** 

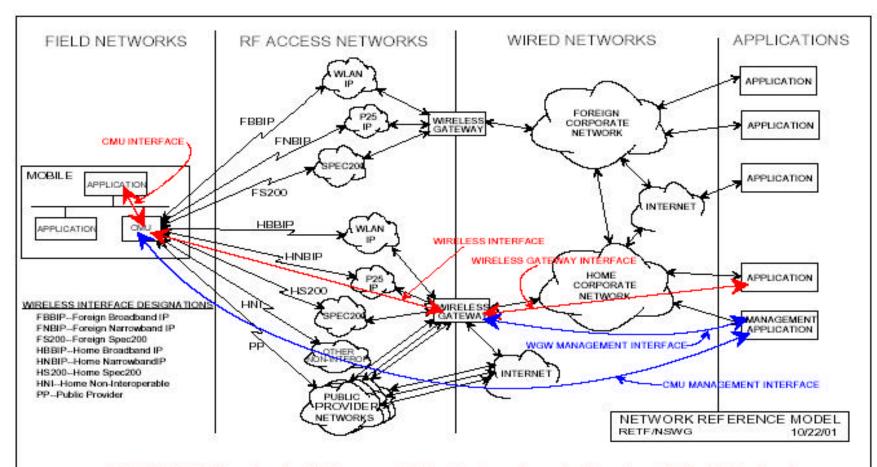
# Schedule

Standard	Status	Final Draft due	Final Spec due
Configuration Management Plan	Incorporated	NA	NA
End of Train Communications	Incorporated	NA	NA
AEI	Incorporated	NA	NA
LSI Operating Display	Final draft	NA	Fall 2003
Radio Communication (Protocol)	Incorporated	NA	NA
Environment	Incorporated	NA	NA
Radio Communications Network	Working draft	April 2003	August 2003
RCL Protocol	Working draft	Spring 2003	June 2003
Locomotive Event Recorder	Final draft	NA	May 2003
Locomotive Architecture	Working draft	April 2003	Fall 2003
Mobile Terminal Architecture	Future	?	?
Wayside Architecture	Future	?	?
Office Architecture	Future	?	?
Data Dictionary	Working draft	Late 2003	December 2003
Messages	Initial dev	Late 2003	December 2003
TC Concept of Operations	Working draft	Not scheduled	?
RSPP Template	Working draft	Not scheduled	?
PSP Template	Future	?	?

# **Network Communications**

- Design will enable multiple communications paths for mobile wireless communications - essentially a "gateway or router" network
- There is a draft outline and reviewed with RETF and WCTF in early February.
- Plan to complete specification for additional RETF review by June
- Scope
  - Encompasses the network and addressing to/from locomotive
     may expand to wayside in future
  - Includes "IT connection" between railroads
  - Defines Gateway functions
- RETF Focus Group led by Ed Hollingsworth of UP

# Network Spec Schematic



CMU INTERFACE—How onboard applications access CMU functions to send or receive data and control other CMU functions. I WIRELESS INTERFACE—Lower layers will depend on specific wireless network, but mid-layer protocols will have to be defined.

WIRELESS GATEWAY INTERFACE--How office apps access send, receive, and other functions of the Wireless Gateway.

CMU MANAGEMENT INTERFACE--How CMUs are remotely configured and managed.

WIRELESS GATEWAY MANAGEMENT INTERFACE--How WGW is remotely configured and managed

# Network Spec – Related Activities

- FRA has a Cooperative Agreement in Wireless Communications with AAR
  - Funding of \$750,000
  - Intent is to set up testing and evaluation of wireless communications components and systems
  - For example testing of Communications Management Unit (CMU) at TTCI
    - Communications test bed is being built at TTCI to support CMU and other com technologies/applications
    - Will set up a CMU test on CSX on CBTM test territory

# Data Dictionary and Message Specifications

- Data Dictionary
  - Have reviewed data dictionary for completeness will review and update "as we go forward"
- Message
  - Developed a "string" to show how a common message (location reporting) will be hosted in UML
  - Are developing three initial messages Office to/from Locomotive
    - Location report
    - Locomotive fuel
    - Vehicle identification
- RETF Focus group led by Larry Milhon BNSF